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ABSTRACT

One of a set of fourteen instructional outlines for use in a course to train novice fireman, this guide covers the topic of rope usage. Developed from and designed to be used with the Brady Firefighting Service Transparencies on rope and the International Fire Service Training Association Manual No. 101, "Forcible Entry, Rope and Portable Extinguisher Practices" (see note), it refers to the appropriate page and figure numbers of the Manual and transparency numbers as guides. Specific directions, as part of a combination lecture and practical application method of teaching, are given to the instructor for demonstrating techniques and testing students, but it is noted that because of the broad scope of the outline, modifications will be needed for its use by particular fire departments. Placing emphasis on how and where rope is used, its limitation, and care, the portion of the course covered in this outline has as its objective the fireman's proficiency in tying all the basic knots and securing a number of items to be raised or lowered by ropes without assistance. A list of required materials is also included. (An outline of the whole course covering all fourteen topics briefly is provided in the first item of the set, CE 016 662.) (ELG)

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INTRODUCTION

Fire Service rope work involves basic knots and hitches necessary for hoisting tools, ladders, hose and extinguishers and for the splicing, care and storage of lifelines and handlines. It is most important for fire fighters to know how to use rope, where to use it, understand its limitations, and how to care for it.

The purpose of this outline is to present accepted rope practices that can be adapted to local situations. The scope of this outline covers the phases of rope practices in a sequential course. This outline was developed from and designed to be used with the International Fire Service Training Associations Manual No. 101, Forcible Entry, Rope and Portable Extinguisher Practices, which has been adopted by the Fire Service Training Division of the North Carolina Department of Community Colleges.

Presentation

In as much as the coverage of this outline is very broad, it will be necessary for the instructor to adapt it to the local Fire Department situation.

This course is designed for the combination lecture--practical application method of instruction.

OBJECTIVE

To develop the fireman's skills in rope usage so that he can demonstrate proficiency before the instructor by tying all of the basic knots and by securing a number of items to be raised or lowered by the use of ropes. Proficiency is demonstrated when the student can perform these tasks without assistance.

REQUIRED MATERIALS

1. Short pieces of rope 6-12 feet length for use by students.
2. Handout material on ropes.
3. Two lengths of rope 50 feet or longer.
4. Blackboard.
5. Rope samples (various types of rope).
6. Rope hose tool.

ADDITIONAL RECOMMENDED MATERIALS

1. Brady transparencies on ropes.
2. Overhead projector and screen.
3. Marlinspikes (for advanced classes).
4. Block and tackle (for advanced classes).
5. Rope coiler.
6. Recommend purchase by student of manual, Forcible Entry, Rope, and Portable Extinguisher Practices, (one per student).

COURSE OUTLINE	GUIDES
I. Rope Materials and Characteristics (knowledge of rope necessary in procuring proper type rope for job).	Brady Transp. Rope No. 1
A. Hard vegetable fiber.	
1. Manila hemp.	IFSTA No. 101, Page 90, Fig. 68
(a) Comes from abaca plant.	
(b) Imported from Philippines.	
(c) Limited use Fire Service mainly for raising objects.	Show manila rope specimen
(d) Characteristics.	
(1) Natural resistance wind, rain and sun.	
(2) Very strong.	
(3) Endures long and hard service.	
2. Sisal hemp.	IFSTA No. 101, P. 90, Fig. 69
(a) Comes from leaf agave plant.	
(b) Imported from Dutch East Indies and Africa.	
(c) Used for ropes and binder ropes.	Show sample sisal rope
(d) Characteristics.	
(1) Substitute for manila hemp.	
(2) Whiter and shiner than manila.	
(3) 75% strength of manila.	

COURSE OUTLINE	GUIDES
B. Synthetic fiber rope.	Show sample glass fiber rope
1. Glass fiber.	
(a) Poor abrasion and flexing resistance.	
(b) Poor strength when wet.	
2. Saran fiber.	Show sample saran rope
(a) Favorable characteristics.	
(1) Rot and chemical resistance.	
(2) Resistance to aging-sunlight.	
(b) Unfavorable characteristics.	
(1) Moderate abrasion qualities.	
(2) Low resistance to temperatures.	
3. Nylon fiber - strength and other properties vary with type of nylon.	Show sample nylon rope
(a) Strength.	
(1) 3-3½ times cotton.	
(2) 1½-2½ times manila.	
(3) 2-3 times sisal.	
(b) Advantages.	
(1) Strength.	
(2) Permits use of smaller rope.	

COURSE OUTLINE	GUIDES
(3) Saves weight.	
(4) High elasticity and recovery.	
(5) High wear resistance (only when dry).	
(c) Disadvantages.	
(1) Wears faster when wet.	
(2) Loses strength when wet.	
(3) Hard to form knots.	
(4) Knots may give or roll under tension.	
4. Polypropylene rope - available corse or fine fiber (similar nylon).	Show sample polypropylene rope
(a) Advantages.	
(1) Less weight than other ropes.	
(2) Great strength.	
(3) Elasticity between manila and nylon.	
(4) Resistance to impact load, mildew, acid, alkali, and sunlight.	
(5) No moisture absorbtion - will float indefinitely.	
(6) 50% stronger than manila.	
(b) Disadvantages.	

COURSE OUTLINE	GUIDES
(1) Fair resistance organic solvent. (2) Fair resistan e to abrasion. (3) Heat effect 250 degrees - melts at 330 degrees.	
5. Polyethlene rope - comes from same family as polypropylene. (a) Advantages. (1) Similar to polypropylene rope. (2) Can be obtained in colors. (b) Disadvantages. (1) Heat effect 230 degrees - melts at 285 degrees.	Show sample polyethlene rope
C. Cotton fiber rope. 1. Used when a soft pliable rope desired. 2. Disadvantages. (a) Poor resistance water or chemicals. (b) Poor tensil strength.	Show sample cotton rope
II. Rope Usages. A. Life lines - used for life belt used in personnel rescue. 1. Safety precautions.	

COURSE OUTLINE	GUIDES

(a) Two persons - 500 pounds limit.

(b) 5 to 1 safety factor.

(c) Proper rope diameter.

(d) Use only for this purpose.

(e) Usually 100 to 125 feet length.

2. Recommended Rope Size

Manila	3/4 and 7/8 inch diameter
Nylon	3/4 and 7/8 inch diameter
Cotton	1 inch diameter

B. Rescue lines.

1. Uses.

(a) Lower victims from upper floors.

(b) Traverse rescue lines.

(c) Raise victims from basements or holes.

(d) Towlines.

(e) Drag lines.

(f) Barricades.

2. Precautions.

COURSE OUTLINE	GUIDES
(a) When rope dries, becomes soft and flabby.	
(b) Treat for resistance to water absorption.	
(c) Use lines 3/4" to 1" size.	
(d) Maintain 5 to 1 safety factor.	
(e) Ease of rope tying.	
C. Hoisting and anchoring lines.	
1. Characteristics.	
(a) Use 3/8 to 5/8 diameter.	
(b) Lengths 50 to 150 feet recommended.	
(c) Flexible for knot tying.	
2. Uses (used where larger rope is unnecessary).	
(a) Hoisting tools and appliances.	
(b) Anchoring ladders and hoses, etc.	
(c) Not used for rescue.	
D. Ladder halyards.	
1. Used to raise and lower fly section of extension ladder.	
2. Halyard inspection.	
(a) Replace when worn.	Have students replace ladder halyard

COURSE OUTLINE	GUIDES
(b) Use 5 to 1 safety factor.	
(c) Replace as new halyard is removed.	
(d) Check for proper size pulley.	
(e) Raise and lower ladder to check operation.	
III. Rope Tackle Terms and Definitions.	
NOTE: <u>This section left to discretion of instructor</u>.	
A. Tackle.	
1. Combination of rope and blocks to increase pull.	Show block and tackle
2. What is gained in pull, lost in speed.	
B. Block - single, double, or treble sheave.	Have students to use
1. Construction.	
(a) Made of wood or metal.	
(b) Pulleys called sheaves.	
2. Block description.	IFSTA Manual No. 101, P. 97, Fig. 70
(a) Cheeks.	
(b) Swallows.	
(c) Sheave.	
(d) Pin.	
(e) Hook.	

COURSE OUTLINE	GUIDES
(f) Straps. (g) Breech. (h) Becket. (i) Thimble. C. Snatch block - single sheave blocks used to give lead to hauling part of tackle. D. Fall - that part to which power is applied for hoisting. E. Luff - Watch Tackle - Handy Billy. 1. Composed single and double block. 2. Used on hauling part of heavy tackle to increase pull. F. Whip. 1. Single or double blocks. 2. Use. (a) Securing. (b) Moving. G. Lashing - rope used for binding. IV. Rope Slings.	IFSTA Manual No. 101 P. 99, Fig. 71

COURSE OUTLINE	GUIDES
A. Definition - a supporting band or strap used in raising or lowering a heavy object. B. Precautions. 1. Load on rope is same as object only on a straight lift. 2. Never lift with an angle more than 90 degrees on sling. V. Selecting the Rope. A. Purchasing. 1. Use only best grade. 2. Second and third grades made from lower grade fiber. B. Safety factor. 1. Proper size for job. 2. 5 to 1 safety factor. VI. Knots and Hitches. A. General. 1. Knot weakens rope at that point. 2. Knots tied for long periods or those which have undergone severe pull leaves rope vulnerable to damage at that point.	

COURSE OUTLINE	GUIDES
3. F. D. knot characteristics. (a) Should be simple - easy to tie. (b) Easily untied. (c) Not subject to slippage. (d) Have minimum number abrupt bends. 4. Tying. (a) Teach simplest way. (b) If student can tie knot another way, do not try to change method.	
B. Principles of tying knots.	Brady Transp. Rope No. 1 IFSTA Manual, P. 101, Fig. 72
1. Bight - formed by simply bending the rope, keeping the sides parallel.	
2. Loop - made by crossing the sides of a bight.	Have students form a bight, a loop and a round turn
3. Round turn - consist of the further bending one side of loop until parallel with other side.	
4. Standing part - part of the rope that is to be used for work, ie. hoisting or pulling.	
5. Running part - part of the rope that is to be used in forming the knot.	
VII. Tying Knots and Hitches.	IFSTA Manual No. 101, P. 103, Fig. C
A. Half-hitch.	

COURSE OUTLINE	GUIDES
1. Uses. (a) Safety backup. (b) Guide for object being raised. 2. Formation - make one complete loop around object.	Have students make half-hitch
B. Timber hitch - a secure, temporary fastening which may be easily untied.	Brady Transp. Rope No. 12
1. Pass running part around object.	IFSTA Manual No. 101, P. 102-103, Fig. ABC
2. Form a loop around standing part with running end to inside.	
3. Wrap running part about itself one or more turns.	Have students make a timber hitch
4. Half-hitch may be used with timber hitch for long articles.	
C. Becket or sheet bend - used to join two ropes of equal or unequal size - not likely to slip when wet.	Brady Transp. Rope No. 3
1. Form a bight in one of the ends to be tied, and pass the other end through the bight.	IFSTA Manual No. 101 Page 104, Fig. 74
2. Bring the loose end around both parts of the bight.	
3. Tuck this end under its own standing part and over the bight standing part.	Have students tie a becket bend
4. Draw the knot tight by holding to each end and standing part.	

COURSE OUTLINE	GUIDES
D. Bowline (for forming a loop or eye).	Brady Transp. Rope No. 4
1. Measure off sufficient rope to form the size of knot desired and form a loop in the standing part.	
2. Pass the running part upward through the loop.	Have students tie a bowline
3. Pass the running part over the top of the loop and under the standing part.	
4. Bring the end of the running part completely around the standing part and down through the loop.	IFSTA Manual No. 101, Pgs. 105, 106, 107, Fig. 75 A-E
5. Pull the knot snugly into place.	
6. May be backed up with half-hitch.	
E. Clove hitch (principle use to attach rope to object such as a pole, post, or hose).	Brady Transp. Rope No. 6
1. Forming in open.	
(a) Form a loop in the left hand, palm up.	IFSTA Manual No. 101, P. 108, 109, Fig. 76
(b) Form another loop in the right hand that is identical to the loop in the left hand.	
(c) Place right loop on top of left hand loop.	
(d) Hold the two loops together and place over object.	
2. Forming clove hitch around object.	Brady Transp. Rope No. 5

COURSE OUTLINE	GUIDES
(a) Make one complete turn around the object so as to bring the running part below the standing part.	
(b) Cross the running part over the standing part and complete the "round turn" around the object above the first loop.	IFSTA Manual No. 101, P. 110, Fig. 77
(c) Pass the running part end under the upper wrap just above the cross and by pulling, properly set the hitch.	Have students tie clove hitch around object
F. Half-sneep shank and safety (used for taking up slack when roping off an area).	
1. With the rope secured to one object, place the running part around another object and bring it back parallel to the standing part.	IFSTA Manual No. 101, P. 111-112, Fig. 78
2. Face the standing part of the line which is secured to the first object, drop the running part across the standing part; then form a bight about 12 inches long just behind where running part crosses the standing part.	Have students form a half-sheep shank
3. Reach ahead of the cross-over point and form a loop in the standing part.	
4. Place the loop just formed well back over the end of the bight to form a half-hitch (forms true half sheep shank).	
5. (For safety) place another half-hitch over the end of bight.	
6. Pull running part to tighten the half sheep shank and make it secure.	

COURSE OUTLINE	GUIDES
B. Chimney hitch (used for taking up slack during an operation - got name from chimney to which it was often anchored).	Brady Transp. Rope No. 8
1. With one end of the line secured and the running part around a stationary object and parallel to the standing part, form a half-hitch around the standing part.	IFSTA Manual No. 101, P. 114, Fig. 79
2. Pass running part through the parallel ropes and form another half-hitch or loop over the half-hitch previously formed.	Have students form a chimney hitch
3. Pull the loop snugly to the side of the half-hitch and wedge the half-hitch against the standing part.	
4. Place one or more half-hitches back of the chimney hitch on the standing part of safety.	
5. Hold the chimney hitch with one hand and pull on the running part with other to tighten rope.	
6. Slip the chimney hitch back on the standing part to hold the rope taut.	
VIII. Hoisting Tools and Equipment.	
A. Hoisting ladders.	IFSTA Manual No. 101, P. 117, Fig. 81
1. Form a large loop in a rope by using a bowline knot. Place the loop between the rungs of the ladder about one-third the distance from one end and under the rungs between the beams.	
2. Place loop over beam ends.	Have students to hoist hose, ladder, and various tools using the proper knots

COURSE OUTLINE	GUIDES

3. The ladder tie is formed by pulling on the standing part of rope.

B. Hoisting hose lines (with or without nozzle).

NOTE: Hose lines should be dry and lowered after draining when practical.

1. Bend hose back to keep nozzle and coupling from striking protruding objects while being hoisted.

2. Use clove hitch and half-hitch.

3. Use same hitch when lowering hose, but do not bend hose back.

C. Hoisting small tools and equipment.

1. Use clove hitch and half-hitch.

2. Examples of equipment for hoisting.

(a) Pike pole.

(b) Axe (uses special hitch).

(c) Portable extinguisher.

(d) Wrecking bar.

(e) Crowbar.

(f) Kelly tool and others similar.

IX. Special Application and Care.

COURSE OUTLINE	GUIDES
A. Crowning a rope end.	IFSTA Manual No. 101, Page 120, Fig. 82
1. Unlay the rope end three or four turns. Hold the rope in the left hand with the loose strands up. Select No. 1 strand on the right side and lay this strand to the left across the end of the rope and between the other two strands, leaving an open bight.	
2. Holding the bight vertical, bring the rear No. 2 strand forward and down over No. 1 strand.	Have students to crown a piece of rope
3. Bring toward you the No. 3 strand, bend back to the right and away from you, passing over strand No. 2 and through the open bight that was formed by strand No. 1.	
4. Form the crown by pulling all of the strands equally until the crown is snug. Tucking the ends of the strands is a process by which the crown is made secure. The procedure is same as when two ends of a rope are to be spliced together. For this, a marlinspike is needed.	
5. Select any loose strand and with the marlinspike, raise the second strand of the main rope to the right of the loose end to be tucked. Pass end of strand through hole made by marlinspike.	
6. Raise strand of main rope next to the right of the one just raised and tuck under it the next right-hand strand of the main rope using same procedure.	
7. Continue the process until a sufficient crown is formed.	
8. Roll under feet on floor; then cut excess strand.	

COURSE OUTLINE	GUIDES
B. Whipping a rope end - designed to prohibit rope fraying and permit end to pass through small holes as a pulley.	IFSTA Manual No. 101, P. 121, Fig. 83
1. Fold the cord back upon itself and place the two strands and bight into one of the rope grooves. Length of inlay should be $1\frac{1}{2}$ times diameter of rope.	
2. Wrap the running part of cord around the rope placing the wrappings next to each other.	
3. Keep constant tension upon the running part of the cord and when the length of the whipping is longer than the diameter of the rope, place the running end through the bight.	Have students whip the end of a rope
4. Pull on the standing part so that the running end is pulled under the whipping.	
5. Cut off excess cord.	
C. Splicing two ropes.	
1. Consist of weaving two ropes together.	
2. Used if there is no object to splice being larger than rope.	
3. Procedure (use of marlinspike is recommended).	IFSTA Manual No. 101, P. 122, Fig. 84 & 85
(a) Unlay rope end 6 or 8 turns.	
(b) Bring ends together with strands proportionately mixed.	

COURSE OUTLINE	GUIDES
(c) Tie opposite strands to keep out of way.	
(d) Select any loose strand; pass under nearest strand to right, then under next.	Have students splice two ropes together
(e) Rotate rope using same procedure for each strand.	
(f) Continue process until completed, then do opposite end in same manner.	
D. The eye splice - used to form a permanent loop or eye in the end of a rope.	
1. Insert first strand under any selected loop and pull snugly.	
2. Point marlinspike toward you and enter it under the loop where No. 1 strand came out and bring it out where No. 1 strand went in.	
3. Make a sharp bend with No. 2 strand, bring it underneath and on the opposite side of the standing line, and pull it through toward you where the marlinspike is.	Have students eye splice a rope
4. Insert the marlinspike where No. 1 strand comes out and bring it out where No. 2 strand goes in.	
5. Bring the No. 3 strand under on the back side of the eye, then force it through where the marlinspike provides an opening.	
6. Pull and work all three strands snugly into place and proceed to weave or tuck the strands as for any other splice.	

COURSE OUTLINE	GUIDES
E. Coiling the handline and lifeline.	Using locale method, have students coil rope
1. Coiling essential to service with minimum delay.	
2. Methods of coiling.	
(a) Using rope coiler.	
(b) Using butt of ladder.	
(c) Using canvas bag - place coil in bag in clockwise direction so that it will uncoil in a counter clockwise direction from the center out and from the top down.	
F. Rope hose tool.	Demonstrate uses
1. Uses.	
(a) Securing hoses or ladders.	
(b) Securing personnel to ladder.	
2. Construction.	
(a) Select 10 ft. piece of 5/8 or 3/4 inch manila hemp.	
(b) Fabricate hook - should be 8" long of 1/4" dowell steel rod with eye on one end and hook on other.	If practical, have students make their own tool
(c) Insert rope through eye and then splice rope ends together.	
G. Inspection and care of rope.	Brady Transp. Rope No. 11

COURSE OUTLINE	GUIDES
1. Inspection - life may depend upon it. (a) After each use. (b) Examine for. (1) Cuts. (2) Severe abrasions. (3) Chemical damage. (c) Musty odor or brownish spots. (1) Untwist and check between strands. (2) If inner fibers break easily, separate or have lost luster discard rope. 2. Care - avoid. (a) Acids - alkalis. (b) Kinks. (c) Improper uncoiling - especially when new. (d) Sharp bends. 3. Care - precautions. (a) For easy handling, stretch new rope its entire length before use. (b) Do not drag rope on ground or over rough and sharp surfaces.	Show rope samples which have suffered some type damage

COURSE OUTLINE	GUIDES
(c) If necessary to pass rope over sharp edges, pad the edges with a board, sandbag, etc., so that the strands will not be cut. (d) Store in a cool place, with good circulation of air and not exposed to sunlight. (e) When not in use, rope should be coiled and ready for an emergency.	

NORTH CAROLINA DEPARTMENT OF COMMUNITY COLLEGES

FIRE SERVICE TRAINING

Rope

Rope should be carried on apparatus at all times. All firemen should have a working knowledge of the use of rope -- for safety, tying off ladders and other equipment, hoisting tools, and for rescue work.

TYPES OF ROPE:

Vegetable Fibers

Manila - Preferred for strength and durability. Imported from the Philippines.

Cotton - Not recommended.

Hemp, Sisal - Weaker than manila. Rough, splinter-like characteristics.

Synthetic Fibers

Nylon, dacron, polyethylene and polypropylene.
Synthetics have greater strength for comparable size.

APPROXIMATE MINIMUM BREAKING STRENGTH OF NEW ROPE

Diameter	3 Strand Nylon	3 Strand Manila	3 Strand Sisal	3 Strand Cotton
1/4 in.	1,200 pounds	600 pounds	500 pounds	400 pounds
3/8 in.	2,700 pounds	1,300 pounds	1,000 pounds	900 pounds
1/2 in.	5,000 pounds	2,600 pounds	2,100 pounds	1,500 pounds
5/8 in.	8,000 pounds	4,400 pounds		
3/4 in.	11,000 pounds	5,400 pounds	4,300 pounds	3,100 pounds
7/8 in.	15,000 pounds	7,700 pounds		
1 in.	20,000 pounds	9,000 pounds	7,200 pounds	5,100 pounds

RESISTANCE CHART

Resistance to	Manila	Nylon	Dacron	Polyethylene	Polypropylene
Mildew	Poor	Excellent	Excellent	Excellent	Excellent
Acid	Poor	Fair	Excellent	Excellent	Excellent
Sunlight	Fair	Fair	Good	Fair	Fair
Melting or Burning Point	380°F.	480°F.	500°F.	265°F.	300°F.
Floatability	Non	Non	Non	Indefinite	Indefinite

REMEMBER:

KEEP ROPE CLEAN AND DRY.

INSPECT FREQUENTLY FOR WEAK SPOTS.

YOUR LIFE MAY DEPEND ON IT.